Water for Energy

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1.1 General information

The Ceylon Electricity Board (CEB) is a government owned and controlled utility of Sri Lanka that takes care of the general energy facilities of the island. The Ministry of Power, and Energy is the responsible ministry above the CEB. The CEB comes under statutory duty to develop and maintain an efficient, coordinated and economical supply system of electricity. Therefore the CEB has to:

- Generate or acquire supplies of electricity;
- Construct, maintain and operate the necessary works for the generation of electricity;
- Construct, maintain and operate the necessary works for the interconnection of Generating Stations and Sub-stations;
- Construct, maintain and operate the necessary works for the transmission of electricity in bulk from Generating Stations and Sub-stations to such places as may be necessary from time to time;
- Distribute and sell electricity in bulk or otherwise.

The ideas behind these obligations sound right, but the problem of the CEB is the shortage of generating capacity. The current installed capacity of 1838 MW (the CEB owns about 90% of it, the private sector owns the rest) allows only a generation of about 6.800 GWh, while far more electricity is needed Because of this, Sri Lankan energy users often have to reckon with power cuts. A 'power cut schedule' (among other things mentioned on the website of the CEB) indicates the dates and time of the power cuts for the next week. This is not an encouraging sign while the demand for electricity has been growing at an average annual rate of 8% and is expected to grow at the same speed in the foreseeable future. According to the CEB's Long-term Generation Plan (1999-2013) about 15.000 GWh is needed in 2013; that means a duplication of the current capacity.

1.2 Hydro versus thermal generated electricity

Sri Lanka lacks reserves of fossil fuels and as a result approximately 70% of its electricity is hydro generated at the moment. However, almost all economical and environmental acceptable major hydropower sources have been maximized over the last two decades, so the CEB has to find other solutions; thermal power for instance. With (financial) help from the Asian Development Bank (ADB), a 163-megawat thermal power station is built in Colombo at the moment that has to relieve the acute power shortages in the region. [Asian Development Bank 20001 In the future more thermal power stations will be built in Sri Lanka to meet the balance.

The major problem associated with the existing hydro electricity generating system is inadequate generating capacity to meet the demand at peak periods and the inability to ensure continuous supply over the whole year due to unreliable rainfall patterns. In addition, all identified new hydro projects are constrained by environmental concerns arising from construction of reservoirs (e.g., soil erosion, silting of reservoirs and the inundation of fertile lands). The advantages of

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thermal power development projects have been recognised in terms of cost effectiveness, capacity and reliability. Only in terms of fuel: thermal power is more expensive than hydropower, especially since Sri Lanka has to import fossil fuels, while water for electricity generation from hydro power is for free.

1.3 Access to energy

Sri Lanka lacks a grid throughout the whole country, but to promote economic growth and social development, the government of Sri Lanka aims for increasing of the rural electricity access. The government has articulated a vision to extend electricity provision to nearly 80% of its population (from the current coverage of about 60%) by the year 2007. This national vision implies extending electricity provision to nearly one million households over the next five years [World Bank, 20021.

1.4 The position in the energy market

With the assistance of the ADB and the World Bank, the government of Sri Lanka has undertaken a restructuring program for the power sector to promote competition and to encourage private sector participation. The existing vertically integrated power sector is to be unbundled so that power generation, transmission and distribution will be handled by separate entities. In view of the increased participation of the private sector in the power sector, the necessity of an effective regulatory framework has also been recognized. The restructuring program includes preparation of a power sector reform bill, establishment of a regulatory commission and other institutional reforms. A power sector reform office has already been set up and has commenced work.

The presented information of the position of the CEB in the energy market is very general, but can affect a research in the power sector. At the moment the power sector in Sri Lanka is vertically integrated and dominated by the CEB, but in the future the sector will be divided into smaller parts and the CEB will experience increased participation of the private sector. Because of the increased participation an open power market will appear. Besides this restructuring of the power sector, the influence of electricity generation from hydro power will also decrease in favor of thermal power generation. This implies a decreasing importance of an arbitrarily hydro power station in Sri Lanka. These changes in the power sector are possibilities to restructure the power sector into an effective, contemporary sector and to implement new plans more easily.

Sri Lanka is heavily dependent on hydropower for electricity. In 1990, about 80% of the entire electricity requirement was met by hydroelectric power stations. During occasional dry years, the country had to depend on thermal power generation. The trend is changing now, and emphasis is shifting towards alternative low-cost power sources.

The demand for electricity has been growing at about 8 percent per annum in the recent times.

Institutions

The history of power generation in Sri Lanka is about 100 years old. The private sector pioneered this industry at the beginning. But the Public sector took over the management in 1927 with the creation of Department of Government Electrical Undertakings. Ceylon Electricity Board was created in **1969,** and since then this institution has been the major establishment for electrical power generation and distribution (Ministry of Irrigation & Power, 1997).

Ceylon Electricity Board (CEB) operates under a Chairman, a Board of Directors, a General Manager, and sub-departments for human resources development, transmission, distribution, generation etc. Provincial management is headed by a Deputy General Manager.

Private Sector Participation: A public owned distribution company titled Lanka Electrical Company (LECO) was created in 1983, and it handles distribution of electricity in selected areas close to Colombo. In 2000, the amount of electricity sales by LECO was about 16% of the total.

Private sector participation in power generation has also increased in the recent past. In the year 2000, private sector operated 11 small hydropower plants and six thermal plants. The total generation by private sector including the hired plants was 1324 Gwh out of a total of 6686 GWh (about 20 percent).

Legislation: The Electricity Act was promulgated in 1951. The Act assumes that generation and transmission are carried out by a public utility and distribution to consumers is handled by local authorities. However, since 1992, distribution is mainly handled by CEB (Ministry of Irrigation & Power, 1997).

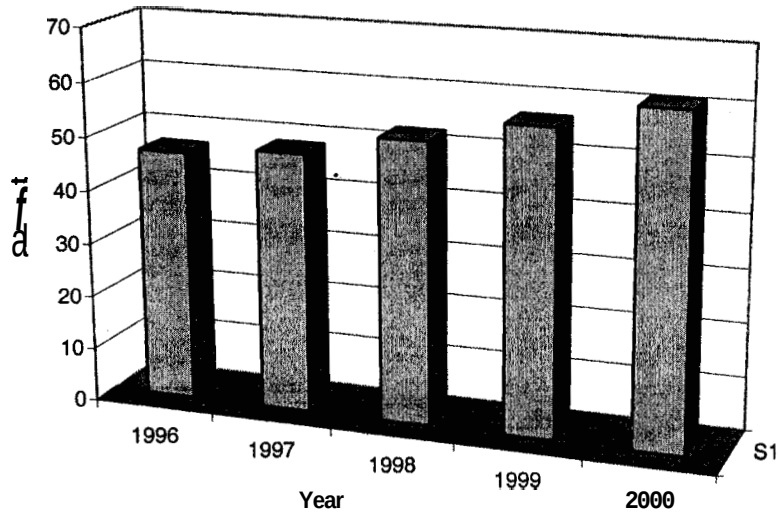
Targets

The Vision statement prepared by Ministry of Irrigation and Power in 1997 states that:

- A reliable supply of grid electricity will be available to at least 80% of the population at affordable prices.
- The industrial sector will have reasonably priced reliable power supply to sustain their competitiveness in the international markets.
- There will be transparent regulatory process where interests of consumers, investors and environmentalists will be adequately safeguarded.
- There will be a non-monopolistic situation in the power sector and it will operate on sound commercial and business principles.
- The private sector will have substantial investments in the sector.
- There will be a reliable distribution and transmission system with losses reduced to internationally accepted levels.

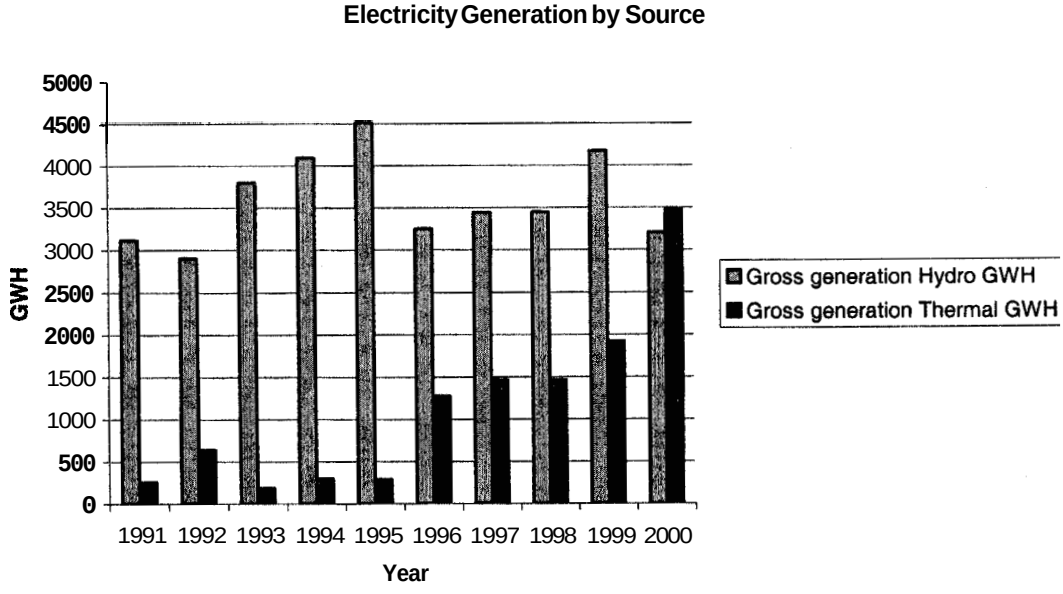
According to the Long-term Generation Expansion Plan of CEB, power generation has to be increased from 6,800 GWh in 2000 to about 15,000 GWh in 2013. The share of hydropower is expected to decrease to 32 percent in 2013. The expected expansion of hydropower generation is low (Central Bank of Sri Lanka, 2000).

Figure 1. Percent Number of Households Electrified.



There is a trend **of** decreasing reliance on hydropower in the recent years. Figure **2** shows that thermal power generation has become as important contributor as the hydropower generation.

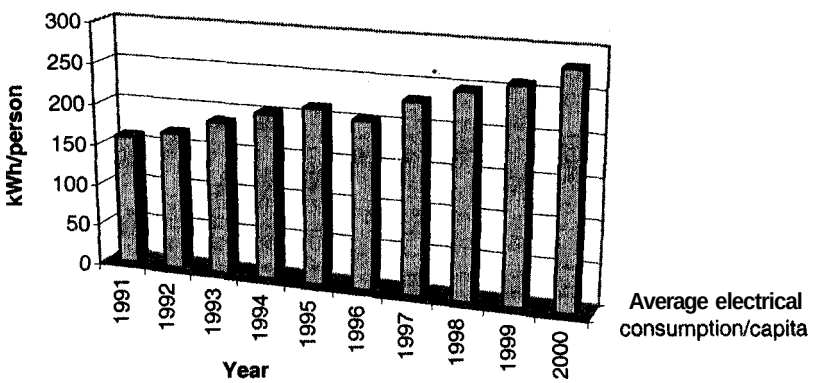
Figure 2. Electricity Generation by Source.



With better living standards, the demand for electricity is bound to rise. The available data show that per capita power consumption has been rising during the past decade.

Figure 3. Average Electrical Consumption per Capita.

(Source: Statistical Digest of Ceylon Electricity Board)



It is obvious that power generation has to be expanded to meet the rising demand. However, the recent droughts have severely affected the generating capacity, and the Government is looking for alternate means of power generation. Like in the case of food security, health and sanitation and domestic water supply, the challenge is to generate power at an affordable price for the general consumer.

Cost of production and tariff structure

The cost of hydropower generation is comparatively low. However, its dependence on good weather conditions has made hydropower an unreliable source. The recent droughts have resulted in power cuts, which affected the economy adversely. Shift towards thermal sources has resulted in a higher production cost.

The overall average cost if power generation increased by 47 percent in year 2000 to Rs. 6.31 per kWh, while the average tariff increase was only 4 percent to Rs. 4.60 per kWh. As a result, there was a net operating loss of Rs. 6.728 million in 2000 (Central Bank, 2001).

CEB tariff structure is based on increasing rates for higher levels of consumption.

Table 1. Changes to Tariff Rates for Domestic Consumption.

Block	1997-2000	2000-2002	From April 2002
First 30 units	Rs. 2.20	Rs. 2.40	Rs. 3.00
31-90 units	Rs. 2.60	Rs. 2.90	Rs. 4.00 (31-60 units) Rs. 4.40 (61-90 units)
90-180 units	Rs. 5.00	Rs. 5.50	Rs. 10.60
More than 180 units	Rs. 6.80	Rs. 7.20	Rs. 15.80

Demand-side management

The main sectors that consume electricity are as follows:
1. Industrial sector
2. Commercial sector
3. Retail sector

Action being taken for demand management in the industrial sector and commercial sector are as follows:
1. Carrying out of energy audits on customer request.
2. Energy audits results implementation and monitoring
3. Power quality studies on customer request

In the case of retail customer, following programs are undertaken:
Compact Fluorescent Lamp (CFL) programme

The total no. of CFL bulbs used in Sri Lanka at present	=	1 million
Maximum peak demand (Electricity) year 2002	=	1450 MW
The total load of Incandescent bulbs	=	200MW
The total load of Compact Fluorescent Lamp (CFL)	=	2MW

The retail customers are provided with 4 CFL bulbs for a pay back period of one year with no interest.

An energy efficient building code for customers has been prepared. This will result in 20 percent saving of energy for existing buildings, and 40 percent energy saving for new buildings.

The energy-labeling programme provides for identifying energy efficient electrical appliances.

In addition there are customer awareness programs including seminars and educational programs.

CEB also carries out load research programmes that would provide information on provincial load shape industrial load shape and TV load shape, etc.

Supply-side Management

In year 2002 expected total energy sales will be approx. 6000 GWh. With the present system loss amounting to approximately 19 percent or 1400 GWh, it is required to Generate 7400 GWh. In order to reduce the system losses by a considerable margin, steps have been taken to improve the Supply side management such as implementing rehabilitation and augmentation of distribution sector.

Normally Generation Planning branch of **CEB** prepares a plan for 20 years ahead with respect to the growing demand and this is based on least cost dispatch system. But due to various reasons such as political instability, ethnic problems, financial instability and environmental issues these plans have not been implemented at the right time and therefore meeting peak demand with increased consumers is a serious problem.

Uma Oya Project

There have been a number of preliminary studies for the development of the hydropower potential in the Uma Oya catchments. Out of these, the latest study done by Canadian International Development Agency in September 2001 was important for Walawe Basin development. They suggested to transfer an average of 192 MCM of water annually from Uma Oya and Mahatotila Oya to the Kirindi Oya basin. It will have the power generating capacity of 90MW with an average energy output of 312 GWh per annum. This additional water flow to Handapanagala and Lunugamwehera reservoirs will help to expand its irrigation capacity by 4995ha.

Elèctrical energy consumption in Ruhuna Basin

It was considered that the Walawe basin contains the electrical distribution areas of Hambantota Kahawatta and Badulla. Even though the distribution areas are not exactly match with the basin, it will give us a closed look at the energy usage in the region.

Total number of consumers (Year 2000) = 194263 (8% of the total consumers)
Total Energy consumed (Year 2000) = 215GWh(4% of the total consumption)
Total energy generated (Year 2000) = 291GWh
Energy export = 76GWh

	Sri Lanka	Hambantota	Kahawa	Badulla	W/Basin	Basin %
Energy (GWh)	5,258	67	76	72	*215*	*4*
Income (RS M)	23,837	286	359	314	*959*	*4*
No. of consumers	2,490,309	66,768	58,093	69,402	*194,263*	8

Power gneration in Ruhunu Basin

There are two major hydropower stations in Ruhunu Basin. Both are located in the Walawe sub basin.

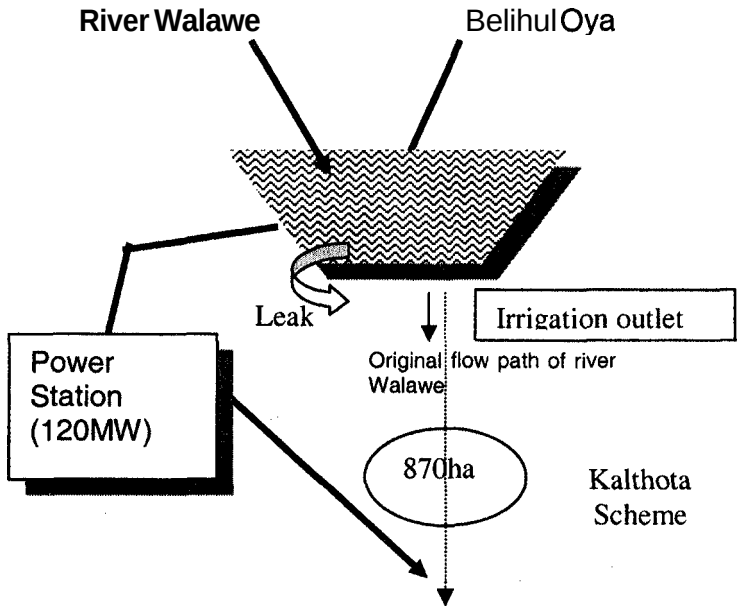
Uda Walawe Project

Uda Walawe Project is a multi-purpose project serving agriculture and power generation. The Uda Walawe Power Station was built in 1964. It has an installed capacity of 6MW of three generators. In general it generated about 6GWh per year.

Sarnanalawewa Project

Samanala Wewa Reservoir is built at the confluence of the rivers Walawe and Belihul Oya and is situated at a place called Kumbalgama. This water is taken initially along a 5.5 km long underground tunnel and finally along a surface penstock to the 120MW Power Station at Kapugala. After Power is generated, the Power Station discharge is released along the Tail Race canal into a stream called Katupath Oya and from there, back to river Walawe.

Figure 04. Location diagram of Samanala Wewa Reservoir, Power Station and Kalthota Scheme.



Sharing water between agriculture and energy

A large irrigation settlement exists in between the points where the water is initially tapped and the point where water is finally released to after generating power. The Kalthota Project, as it is called, has over 2000 families whose sole lively hood is agriculture and that too is from the water discharged from the reservoir.

There also exists a water leak from the Right Bank of Samanala Wewa Reservoir. This water meets the original flow path of the river Walawe (and Belihul Oya) before reaching Kalthota. (See figure 04)

In addition to any discharge from the dam through bottom irrigation outlets, the water from this leak is the only guaranteed source of water for the farmer settlement at Kalthota. However, as the water from the leak **is** not adequate to meet their total demand, from time to time, water **is** released through the bottom outlets of Samanala Wewa dam too to meet the balance.

Methodology of Water releases

Every year, water is released from Samanala Wewa reservoir for Irrigation purposes through irrigation outlets for the aforesaid purpose. There is an Irrigation Officer stationed at Kalthota who comes under the purview of the Irrigation Engineer Ratnapura. Twice every year, a meeting is held at Kalthota, which **is** represented by the Div Secretary, Irrigation Engineer Ratnapura, Officers of the Agriculture Department and representatives of the farmer community. **At** this meeting, a decision is taken as to the dates of commencement of water releases to farmers at Kalthota for the next season and also in what quantities. Later, these details were further discussed at a meeting held at the water management secretariat, which is represented by officials

from C.E.B, the director and deputy director of Water Management Secretariat, Officers from the Mahaweli Head works, and Representatives from Water Board. **As** per the results of this meeting, a schedule is made as to how water from the Samanala Wewa reservoir should be released.

The water management meetings there after are held every week. They review the entire water situation in Sri Lanka both for agriculture and Power generation. Upon the outcome of these meeting, Samanala Wewa Power Station is informed via the System Control Center of the Ceylon Electricity Board the amount of water that is authorized to be released for Irrigation for the next week. Usually a discharge is determined for a week. Any subsequent variations if required has to be sanctioned by the water management Engineer of the system control center of C.E.B. If any change to the existing water discharge is to be done according to the knowledge of the Irrigation Officer Stationed at Kalthota, first his request has to be conveyed to Samanala Wewa Power Station via a radio message link. Then, the shift Engineer at Samanala Wewa Power Station informs the water management engineer of the system control center about the request. Based on his decision, the water discharge from the Dam can be varied.

The Samanala Wewa dam too is unmanned and is situated about 25km away from the Power Station. Thus, usually it takes about 1 hour to execute such request upon the receipt of the instructions.

Evaluating the value of discharge (direct and indirect)

The water released from the Samanala Wewa dam for irrigation has a very high "Opportunity cost" attached as mentioned before since the option of generating power out of this has to be forgone.

The attached Figure 05 describes the total inflow and Power Generation since 1993 to year 2002. Figure ***6*** describes the Power Station Recurrent Expenditure and Figure **7** describes the opportunity cost attached with irrigation releases. Figure **8** describes the Water Releases to Kalthota through Leak and Irrigation Valve and the Cost comparison of Power Generation Revenue, Recurrent Expenditure & opportunity cost of Irrigation releases are describe in Figure 9.

The water discharged from the Samanala Wewa dam (from the leak and/or from irrigation discharge from the outlets) are received by the Kalthota scheme and diverted to either sides of the Walawe river through channels to irrigate the right and left bank.

Some statistical details of the Kalthota scheme, their agricultural production and water utilized by them for the year 2001 are given below.

1. Total land extent cultivated = 865.5 Hectares
2. Total number of families = 1501 as per official records
3. Total yield = 8310 Metric Tons
4. Selling price per Kg of paddy in 2001 = Rs. 15/=
5. The value of total yield = Rs. 124,650,000/=
6. The total discharge (leak + irrigation) = 93 MCM
7. The Total discharge from the Irrigation outlets = 401 MCM
8. The opportunity cost of irrigation discharge to = Rs. 210,000,000/=

CEB (1 units = Rs. 7/=)

9. The value of total production corresponding to Irrigation discharge = Rs. 62,325,000/=
10. Net loss = Rs. 147,675,000/=

Recommended solutions

Introduction of system of Rice Intensification (SRI), paddy cultivation system to Kalthota scheme is one of the recommended solutions. There are quite a lot of information, articles and pictures of farmlands from all major agro ecological zones and some specific regions of our interest of performance. SRI farmers exceed 4000 now in 19 districts achieving 5 to 17 MT/HA according to news reaching us.

This is a win-win solution for the problem.

The benefits are;

a. The income of farmers will be increased
b. Saving of 30 GWh of Energy to CEB and recovering the current loss of Rs 210 Million
c. Emission of 18000 MT of Co_2 to the environment can be eliminated due to reduce Thermal Generation by 30 GWh
d. Less Methane Emission
(Note CO_2 & CH_4 are known substances, which caused Global warming).

Stakeholders

a. 11 Nos of Farmer Organizations at Kalthota Irrigation Scheme.
b. District Planning Secretariat, Ratnapura.
c. Agriculture Department.
d. Irrigation Department.
e. Sabaragamuwa Provincial Council.
f. Samanala Wewa Power Station, Ceylon Electricity Board.

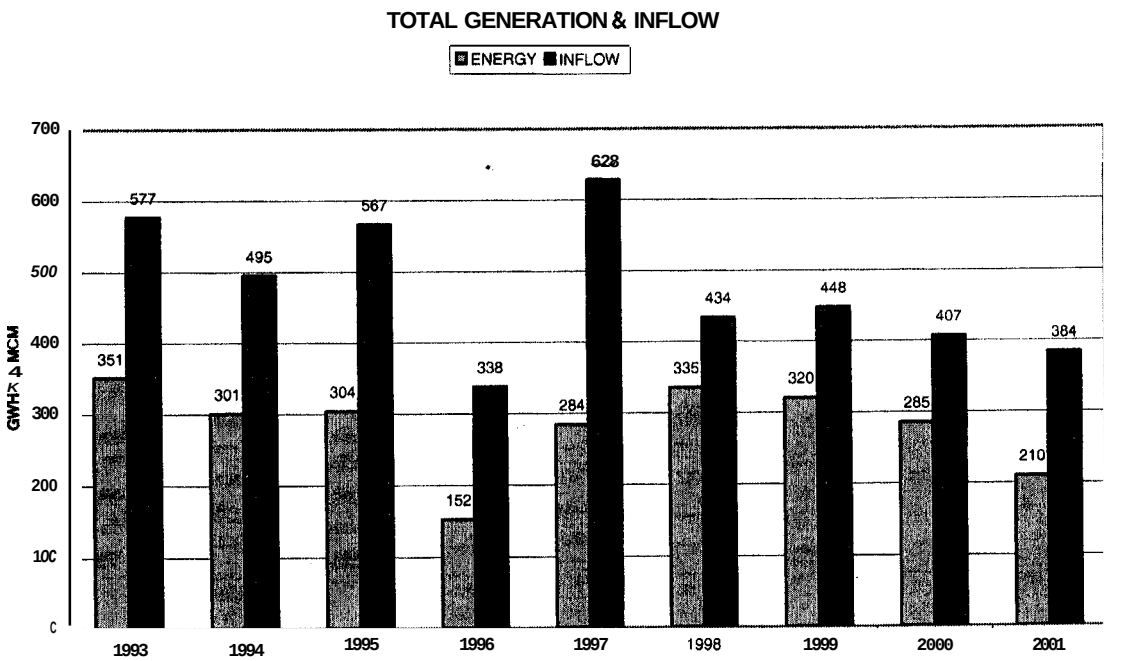
Financing

Ceylon Electricity Board will bear the cost in implementing this SRI project. This includes the expenditure for seed paddy, machineries and insurance coverage.

References

Central Bank of Sri Lanka. 2001. Annual Report 2000
Ministry of Irrigation & Power, 1997. Power Sector Policy Directions

Figure 5.



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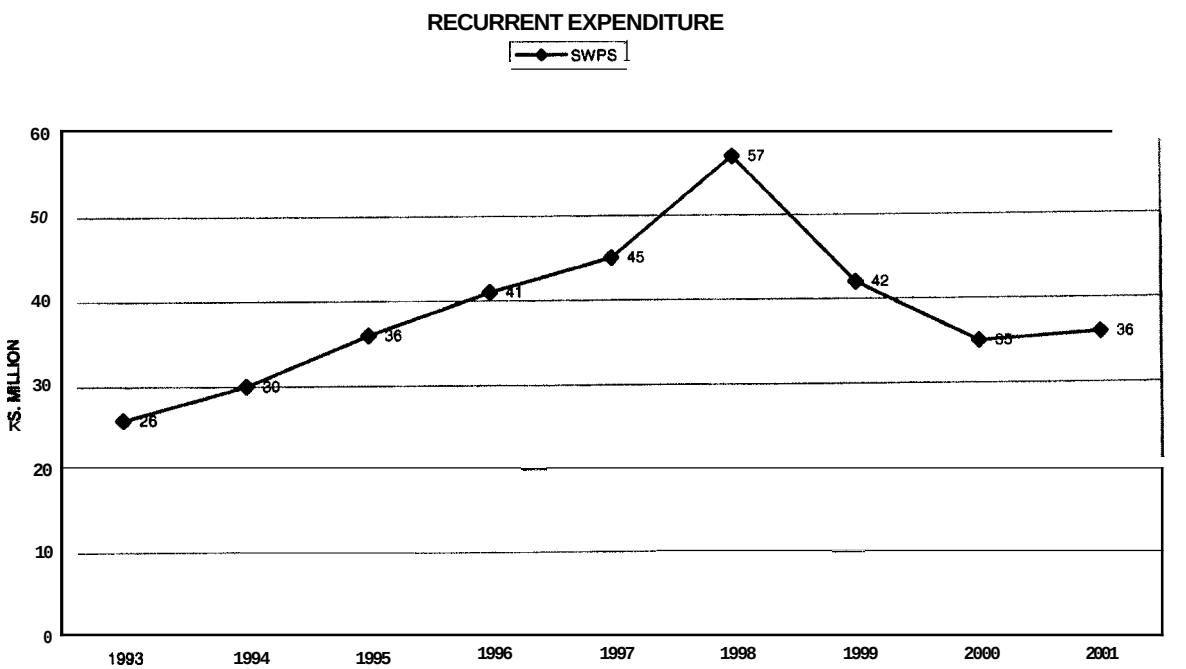


Figure 7.

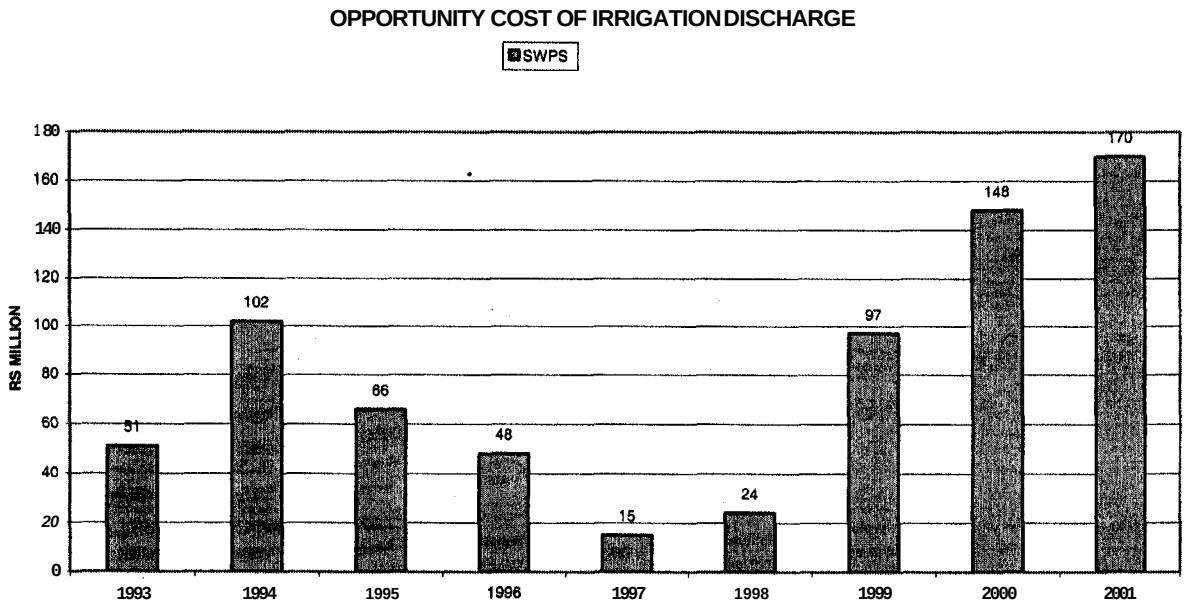


Figure 8.

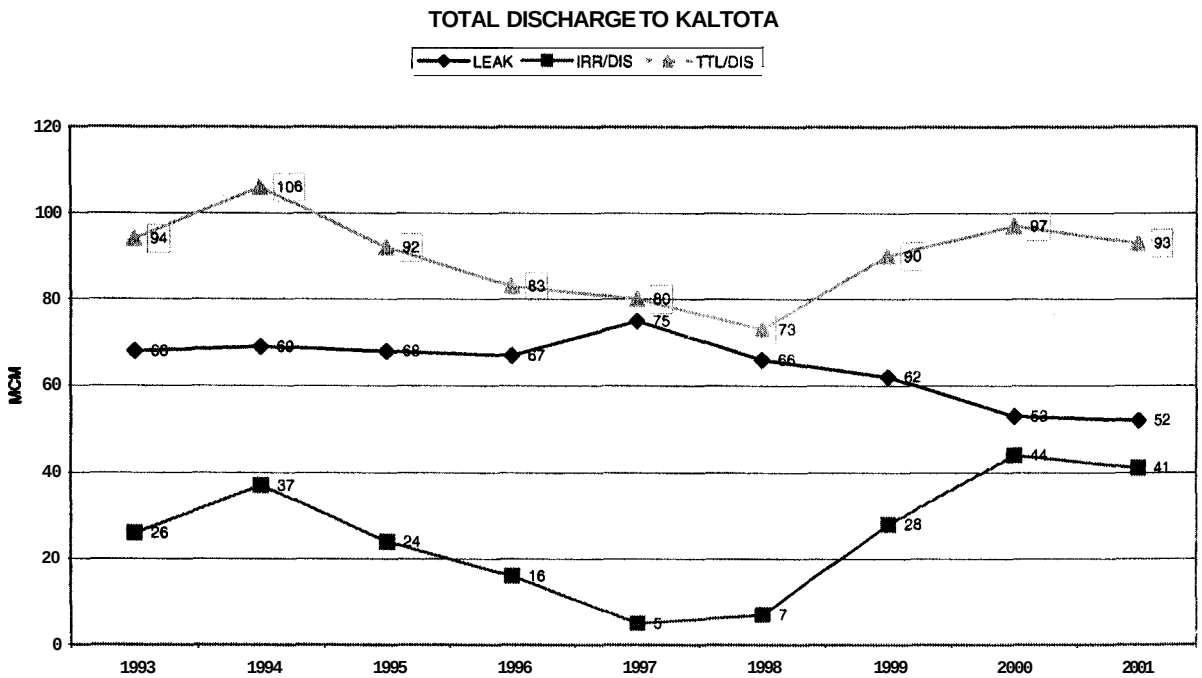
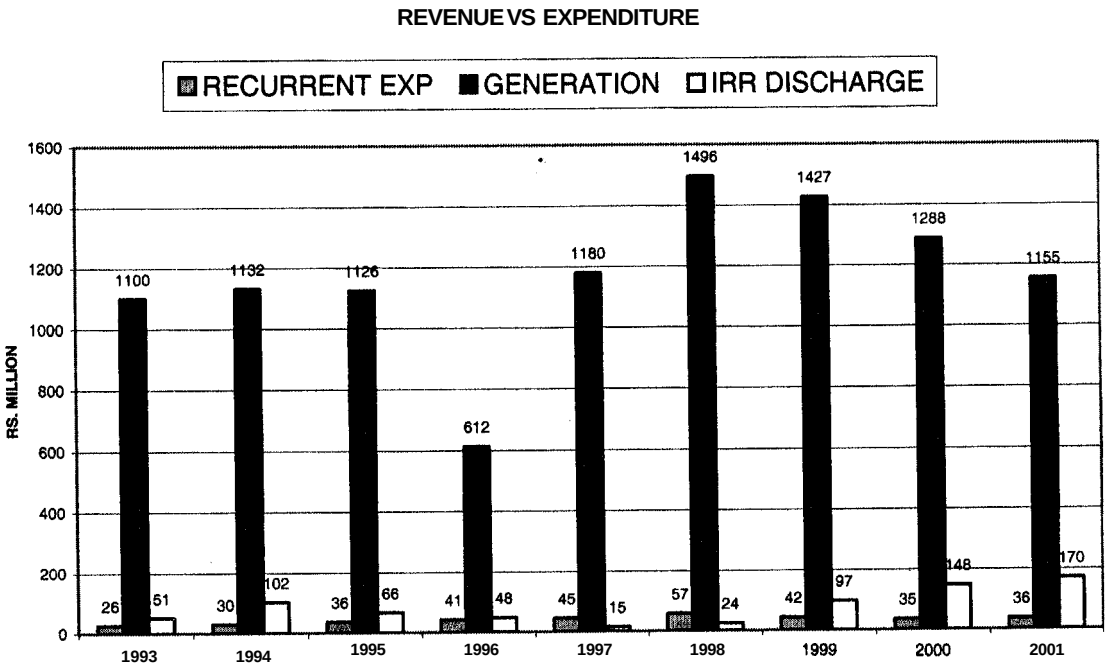


Figure 9.


REVENUE VS EXPENDITURE
RECURRENT EXP
GENERATION
IRR DISCHARGE
RS. MILLION
1600
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